LARGE ANIMAL MORTALITY COMPOSTING GOES MAINSTREAM

DUE to the general consolidation of the industry, meat rendering plants are fewer in number, and farther in proximity from the livestock farms that have traditionally relied on rendering to process mortalities — those animals that die prematurely on the farm. While farms used to be paid by rendering plants for mortalities, now they are charged for the same service, if the service is available at all. The dwindling availability and rising costs of rendering services has placed many livestock producers in a tight spot. Left with tons of mortalities to deal with on a daily basis, the alternatives, burial and incineration, are not altogether attractive. Enter composting, a technique well known to farmers as a manure management option. It has captured the attention of livestock producers as a means to manage mortalities, or "deads" as they are sometimes called. In the past few years, composting of livestock mortalities has advanced from a novel and experimental idea to a viable and almost common practice — as it has been for some time in the poultry industry. Starting with the basic two-bin approach used by poultry growers, researchers and livestock producers have continued to improve methods for composting and preparing carcasses for composting. New techniques are emerging including grinding of carcasses, contained composting systems and the use of conventional windrows.

The evolution and expansion of mortality composting is evident in activities that have recently taken place in Colorado, a state with a large and economically important livestock industry. Some of these activities have been stimulated by public agencies. For instance, the Colorado Governor's Office of Energy Management and Conservation (OEMC) recently sponsored several projects examining on-site composting of hog mortalities. Based on these projects, the OEMC produced a manual for composting hog mortalities. In other cases, livestock producers have taken to composting mortalities at their own initiative. Whether the impetus has been public or private, the developments in Colorado epitomize the national trends.

Composting has captured the attention of livestock producers as a means to manage mortalities. Activity in Colorado is a case in point.

Robert Rynk

COMPOSTING IN BINS — THE STANDARD APPROACH

The standard method of composting mortalities is to layer the mortalities in bins, with each layer of carcasses sandwiched among generous amounts of sawdust, chopped straw or other bulking agent. Typically, a set of two bins is used. After the mortalities compost passively for several months in one bin, the material is turned into the next bin for an additional stage of composting. This basic approach was developed by the poultry industry for composting bird mortalities. It has been adopted for composting large animals with several variations in bin construction, materials, materials handling and equipment.

Frank Haywood, with pH Environmental, LLC in Eaton, Colorado, has conducted several livestock mortality composting projects in the western U.S. At the 33rd Annual BioCycle National Conference in Denver (May 5-7, 2003), Haywood described a two-phase passive aeration process for composting mortalities in bins. In phase 1, layers of mortalities and the surrounding bulking agent decompose at high temperatures (>130 °F) for roughly three months to the point where the soft tissues of the mortalities are virtually eliminated and bones have softened considerably. After phase 1, the materials are turned into a second bin for phase 2. During this second phase, the remaining active organic compounds, now well incorporated with the bulking agent, decompose further and become compost, while most of the bones disintegrate. After phase 2, the compost is ready for field application or further curing, if necessary. The entire process typically takes six months but can be as short as three months

The standard bin method of mortality composting involves multiple bins, like those constructed of large straw bales shown on the left. Starting with a thick base of bulking agent (below), mortalities are added in layers, with each layer covered with bulking agent (right) until the bin is nearly filled and then capped.

or as long as a year depending on the combination of materials, composting conditions and carcass preparation.

The two-phase method for composting mortalities in bins is well described in the OMEC's hog mortality composting manual, which Haywood coauthored with OEMC staff. Most of the effort involves filling the bin to launch phase 1. The procedure starts with a 12 to 18-inch layer of bulking agent at the base of the bin to absorb liquids released as the mortalities decompose. Afterwards mortalities are layered, with bulking agent separating the adjacent layers. Layers are built up to 18 inches from the top of the bin. The final 18 inches is reserved for a cap of bulking agent that covers and insulates the carcasses below. As a rule of thumb, Haywood suggests that, conservatively, one cubic foot of bulking agent is needed for each ten pounds of mortality. The amount of bulking agent needed can be reduced by vigilant management, preprocessing of bulking agents and mortalities and adding fresh manure or other feedstocks.

Bins are sized according to the amount of mortalities generated. Individual bins typically range from 12 to 18 feet in width and length, six to ten feet in height and 1000 to 2000 cubic feet in volume. According to the OEMC manual, under standard conditions, there should be about 1.5 cubic feet of combined bin capacity for every ten pounds of mortality for phase 1. Again, this estimate is conservative. The space required can be reduced by using less bulking agent, as described above. Each facility should have several phase 1 bins operating because a single bin should be filled and capped with-

Grinding of large animal carcasses is a recent innovation in mortality composting. Composters in Colorado have used a mobile grinder-mixer with a tub-shaped hopper and vertical augers with slicing knives (below). Grinder-mixers produce a material with the remains of the mortalities well-distributed within the bulking agents (bottom).

in a reasonable time frame. Haywood recommends that a given bin should be filled within ten days, and preferably within seven. This keeps the material in the bin at a relatively uniform degree of decomposition, lessens the effects of inclement weather and minimizes the chance that carcasses will harbor flies and attract scavengers before the cap is in place. The OEMC manual suggests that the capacity of phase 2 bins can be half that of the phase 1 due to shrinkage.

There are any number of variations to the bin composting method in regard to materials, equipment and procedures. Appropriate bulking agents include sawdust, wood chips and chopped straw and cornstalks. Other feedstocks can be added to enhance the compost or composting process. "Adding manure to the mortality and bulking agent mixture supplies microorganisms and nutrients, and reduces the composting time," says Haywood. The specifics of bin construction and management also vary among facilities. The bins, which are usually three-sided, can be constructed from a variety of materials including wood, tires and straw bales. The need for a roof depends on both the atmospheric and regulatory climate. For example, at the Purina Mills Research Center in Grays Summit, Missouri, the mortality composting bins are 12 feet wide, 24 feet deep and seven feet high and have concrete walls that are open at both ends. The series of bins are covered with a roof because it is a model operation, viewed by the Center's many visitors. At this facility, the material is turned into an adjacent bin four times over a nine month period (see "Composting Carcasses and Manure at Missouri Research Center," July 2002).

The two-bin layered carcass method is a proven and practiced method of mortality composting with the advantages of simplicity, low maintenance and relatively low initial costs. However, it requires diligence in filling the bins, a large proportion of bulking agent, numerous bins and considerable space for the bins and storage of bulking agents. Thus, researchers and composters have been exploring ways to improve upon this basic method. One factor getting attention is preprocessing of the carcasses.

> With the advances being made, composting of livestock mortalities is on the verge of becoming standard practice.

THE GRISLY ADVANTAGES OF SPLAYING AND GRINDING

Large animals require slightly different handling methods than poultry mortalities. Because of their large size and dense bones, swine, cattle and horse bodies decompose more slowly. Furthermore, the hide of the animal is an effective barrier, designed by nature to protect the interior of the body from invading organisms. To promote decomposition of a carcass, it helps to puncture, splay or cut it into pieces. This preparation step makes the task more cumbersome and disagreeable but it can reduce the composting time considerably for carcasses greater than 30 pounds. Thus, hand splaying carcasses (i.e. slicing lengthwise and flattening) has become a standard step in composting large animal mortalities. Haywood estimates that hand splaying reduces the required composting time from one year to 180 days, or even 120 days. Carcasses should be splayed after being placed in the bins. If the animals are cut prior to placement, the internal organs are difficult to contain and transport.

Taking size reduction further, mortalities are now being ground up prior to composting. The types of grinders that have been used in Colorado are vertical grinder-mixers. These machines are commonly used for grinding hay bales and mixing the hay with grain and liquid feeds to produced a feed ration for cattle. In the case of mortalities, the carcasses are ground and mixed with bulking agents. These grinder-mixers have a liquid tight tub-shaped hopper that contains two vertical augers. The augers mix the contents by pulling the material into the center and up from the bottom of the tub, creating a "volcano-like mixing action," as Haywood describes it. Knives are mounted on the auger flights that slice the bulking agents and mortalities as the materials are mixed.

Vertical grinder-mixers operate in a batch mode. All of the materials are loaded, then processed and then unloaded via a screw or belt conveyor. Because they are normally used for proportioning feeds, most grinder-mixers have a built-in scale, which helps in controlling the ratio of bulking agents and mortalities. Experience has shown that the bulking agents must be loaded before the mortalities are added. Otherwise the liquids from the mortalities tend to splash out of the tub, which is not a desirable effect. Bulking agents, such as corn stalks and straw, should be ground in the grinder mixer before loading the mortalities. This type of grinder is not aggressive enough to grind wood. Therefore, woody bulking agents should be preshredded to the desired size (e.g. less than three-quarters inch) using a chipper,

shredder or hammermill.

Grinding of mortalities is a relatively new practice that is still being tested and improved. However, initial experience is showing several advantages. Grinding produces a relatively homogeneous mixture that can be composted in either bins, vessels or windrows. There are no longer whole carcasses that need to be encased in bulking agent. This greatly reduces the amount of bulking agent required compared to just splaying. The OMEC manual notes that grinding nearly reverses the bulking agent to mortality proportions from 4:1 to 1:4 by weight (bulking agent:mortalities). Haywood estimates that grinding and mixing can reduce the required composting time from 180 days to 120 days or less (as low as 75 days). All of this has a significant effect on the economics of mortality composting.

CONTAINED COMPOSTING OF MORTALITIES

There are inherent benefits to composting animal mortalities using in-vessel composting systems. The mortalities are isolated from the surrounding environment, reducing the risk of odors and scavengers plus the effects of weather. The containment decreases the amount of bulking agent required because the carcasses do not need to be fully covered and the need to absorb liquids is not as critical. Also, because of the added degree of process control, contained composting systems tend to accelerate the composting process compared to passively aerated systems like bins.

Ace Compost (Ace) in Yuma, Colorado began composting hog mortalities and after-birth in October 2002. Ace composts the mortalities generated by two large hog farms located within 20 miles of the facility. The composting facility takes in an average of eight tons per day of hog mortalities. Processing this load of mortalities would require well over an acre just for the footprint of the bins using the traditional 180-day two-bin splayed-carcass approach. Instead, Ace composts the mortalities and bulking agent for about 75 days using a grinder mixer and a BW Organics rotating drum digester, followed by passive piles and windrows. Although the entire site is ten acres, the working area occupies only three acres and the footprint of the drum, passive piles and windrows is less than a half-acre. The BW Organics digester has been used for poultry mortalities. For large animals grinding is a necessity, not only because of the relatively small loading port on the end of the drum but also to achieve the desired degree of decomposition in the drum.

The Ace composting facility is not continually staffed. Because of biosecurity concerns, there are similar but separate receiving systems for the two hog production companies including entrance gates, roads, truck scales and receiving wagons. The companies have access via an electronically controlled gates and weigh in each load of mortalities on truck scales. After entering the facility, the trucks back up a loading ramp, dump their load into a mobile receiving wagon and leave. When the facility operator arrives, the grinder-mixer is loaded with the appropriate amount of wheat straw and corn stalks. The amount of bulking agent is determined by the weight of mortalities delivered, as indicated by the truck scales. Usually the bulking agents amount to 20 percent (by weight) of mortalities. The grinder-mixer has a built-in scale to help in proportioning the mix. Once the bulking agents are ground, the mortalities are dumped into the grinder-mixer directly from the receiving wagon. Ace uses a Schuler ver-

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At Ace Compost, each hog production company delivers mortalities to a separate receiving hopper wagon (left). The wagon hydraulically loads carcasses and afterbirth directly into the grinder-mixer (right).

tical grinder-mixer to process and blend the mortalities with the bulking agents. According to Roc Rutledge, the owner and manager of Ace Compost, Schuler modified the basic design of the grinder-mixer to include more knives on the auger, stationary knives mounted on the tub and a different auger to adjust to the conditions of processing large carcasses.

After grinding and mixing for 15 to 45 minutes the mix is unloaded onto a pair of belt conveyors and then to a screw conveyor that loads the mix into the composting drum. "The screw conveyor has been the most troublesome of several problems in the materials handling and composting system," says Rutledge. However, after "reengineering and double reengineering" the components, he has worked through the initial start up problems.

The rotating drum, which is ten ft. in diameter and 50 ft. long, is the first step in the composting process. The purpose of the drum is to contain the process and odors while accelerating decomposition to the point where the material leaving the drum is unlikely to produce odors and attract pests. Based on Rutledge's observations so far, the drum has been working well. "The composting process does not create an odor. The main smell occurs when initially processing the mortalities in the grinder" he says. After loading, the mix of mortalities and bulking agents tumble through the drum for about three days without forced aeration. As the drum rotates, the partially composted mix at the end of the drum falls out through unloading doors. The doors remain open six to seven hours daily at the Ace facility, depending on the amount of mortalities received daily. To facilitate the unloading, Rutledge has cut three additional unloading doors, 12 x 24 inches, into the drum (the original doors measure 12 x 14 inches).

The material that is discharged from the drum falls onto a belt conveyor. The conveyor piles the partially composted mix in a storage pit where it remains and composts passively for 15 days, at temperatures averaging above 140°F. At this point enough material has accumulated to form a full windrow, approximately 12 ft. wide x 8 ft. high x 100 ft. long. Each of the four windrows at the site are maintained for 60 days. Generally, windrows are turned with a bucket loader every 15 days. However, in the summer, the newly formed windrow is turned every three days (i.e. 4 times over 15 days) to discourage fly breeding in the outer layers. When space is needed for a new windrow, the oldest windrow is removed and the material is applied to cropland or stored for later use.

In less than a year, Ace has developed an efficient composting system for handling mortalities. By Rutledge's estimates, it takes two to four hours per day to process the mortalities and move materials among the various composting stages. With significant start-up costs and ample technical know-how and effort by Rutledge, a working system is now in place. To help cover the capital expense, Ace is considering expanding by offering its services to other farms in the area. "At this site we are considering an additional nine tons per day of cattle mortalities from four feedlots," says Rutledge. This will require an additional digester plus another grinder, one that is capable of handling cattle. "If we handle additional hog mortalities, it will be at other sites, located close to other hog producing farms," notes Rutledge.

COMBINING MANURE AND MORTALITIES IN WINDROWS

Teague Diversified in Ft. Morgan, Colorado operates a 25,000 head cattle feedlot plus a farrow-to-finish hog operation. The farm began composting manure and mortalities in 2000, due to the changing rendering situation. "What got our attention a few years ago was that the renderers said 'We are going to start charging you for picking up your dead animals,'" recalls Gary Teague, a principal owner of the farm. One

After grinding and mixing bulking agent and mortalities, a set of conveyors loads the mix directly into the rotating drum digester at Ace (above). Following three days of composting in the drum the material has been decomposed enough to continue composting in an open passively aerated pile (right).

thing that I refuse to do is send our customers a bill for a dead animal. So, we had to find another way to handle our mortalities." That other way became composting.

The approach that Teague decided to take was to combine composting of manure and mortalities. They established an eight-acre windrow composting site at the edge of the feedlot. Most of the windrows are dedicated to composting manure. The remaining ten to 15 percent of windrows include livestock mortalities with the manure. Teague acknowledges that they knew little about composting when they started but with intuition, patience and trying new ideas, he and Gene Love, the compost operations manager, established a system that "works pretty well." A key to successfully composting mortalities in Teague's system is to establish and maintain high temperatures in the windrow, allowing the mortalities to "cook" for several weeks. This decomposes the tissue and hide and substantially softens the bones. Another key is to keep the carcasses covered and isolated within the windrow until they have decomposed. In order to build windrows large enough to contain a full-grown cattle carcass, the farm has purchased a larger tuner, a Wildcat self-powered straddle-style (185 hp, Model TS 514).

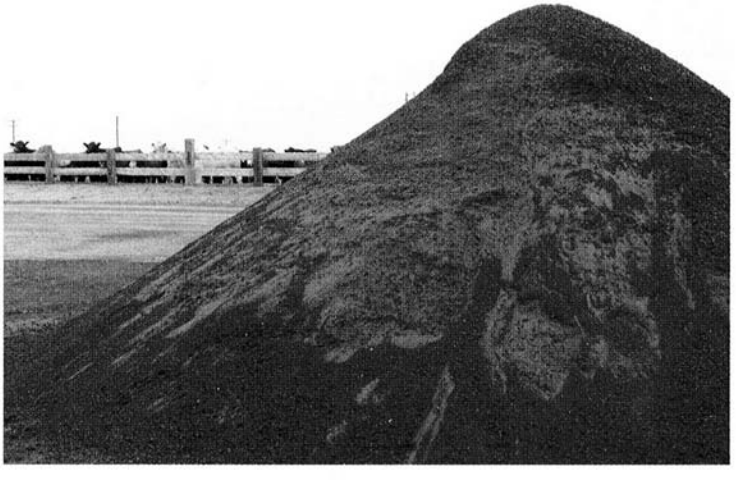
Mortalities are collected daily at Teague Diversified feedlots and swine houses and placed next to active windrows (above). They are covered promptly and composted passively for a month or longer before the first turning.

The procedure begins by starting windrows with manure only. Once a manure windrow heats up, the daily mortalities are laid next to the windrow as they are collected from the feedlot and swine houses. Several times during the day, mortalities are covered with the already-hot manure, creating a windrow roughly six ft. high by 14 ft. wide. Afterwards, temperatures in the windrow rise and typically hold steady between 160° and 170 °F, according to Teague. The combined manure-mortalities windrow is left undisturbed for 30 to 45 days, until the temperature falls to near 100 °F. Then the windrow is turned. In this time, the carcasses have substantially decomposed and the bones have softened. Experience at Teague Diversified indicates that turning the windrow too soon drops the temperature and interrupts the critical period of initial decomposition. As a result, the bones harden and resist further degradation.

At the first turning, the turner effectively works like a grinder-mixer, shredding the decomposed carcasses and incorporating the remains into the manure. Although some bones and small pieces of hide may be visible, the mortalities have largely disappeared and are no longer an attractant to vectors. After the first turning, the manure-mortality windrows are managed in the same way as the all-manure windrows. The windrows are turned at intervals between ten and 20 days, depending on the windrow temperature patterns. The material remains in the windrows for a total of 90 to 120 days, varying with the season and compost use. To remove any remaining bones, the finished compost is screened to 1-inch minus using a ProScreen trommel screen (model 1605). Some of the screened compost is sold and some is used on the farm's cropland. The screen overs, primarily bones, are recycled back into active windrows.

For Teague Diversified, the windrow system works well. With their positive experience, the farm is considering expansion of the mortality composting operation to handle mortalities generated by other farms in the area. "We think that we have a low cost efficient system," says Teague. "This process has to be self-supporting. That is why we got into composting of mortalities."

As the foregoing Colorado examples suggest, mortality composting is advancing at a brisk pace, driven by the acute need to find alternatives to rendering. Well-practiced procedures of composting mortalities in bins continue to be used and improved. However, mortality composters have also pushed further up the learning curve, exploring different methods and materials to make the composting option more practical and economical. In particular, grinding of large carcasses has arrived on the scene and is showing substantial savings in materials, time and space. Given the nature of the process of composting, grinding of carcasses is a logical move. For larger operations, the main drawback to grinding is simply the unpleasant idea of it (for small operations the main drawback is the cost of equipment). However, livestock producers are as accustomed to dealing with dead animals as they are skillful at raising live ones. If splaying, grinding or composting a carcass is a step forward, they will take that step. With the advances being made, composting of livestock mortalities is on the verge of becoming a standard practice. ■



Screened finished compost at Teague Diversified shows no evidence of mortalities, including bones. The few bones that remain after composting are removed by screening to less than 1-inch.